

**Application for Certification
For a Transmitter.**

Vutility Inc.
126 W. Sego Lily Drive, Suite 150
Sandy, UT 84070

Limited Modular Transmitter LoRa (FHSS)

M/N: VUHDC1

FCC ID: 2APCG-VUHDC1

REPORT # UT06070B-004

This report was prepared in accordance with the requirements of the FCC Rules and Regulations Part 2, Subpart J, 2.1033, Part 15.247, RSS-247 Issue 2, and other applicable sections of the rules as indicated herein.

Prepared By:

DNB Engineering, Inc.
1100 E Chalk Creek Road
Coalville, UT 84017

13 Jun 2020

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Paragraph numbers in this report follow the application section numbers found in the **FEDERAL COMMUNICATIONS COMMISSION** Rules and Regulations, Part 2, Subpart J for Certification of electronic equipment.

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1.0 ADMINISTRATIVE DATA

1.1 Certifications and Qualifications

I certify that DNB Engineering, Inc conducted the tests performed in order to obtain the technical data presented in this application. Also, based on the results of the enclosed data, I have concluded that the equipment tested meets or exceeds the requirements of the Rules and Regulations governing this application.

1.2 Measurement Repeatability Information

The test data presented in this report has been acquired using the guidelines set forth in FCC Part 2.1031 through 2.1057, Part 15. The test results presented in this document are valid only for the equipment identified herein under the test conditions described. Repeatability of these test results will only be achieved with identical measurement conditions. These conditions include: The same test distance, EUT Height, Measurement Site Characteristics, and the same EUT System Components. The system must have the same Interconnecting Cables arranged in identical placement to that in the test set-up, with the system and/or EUT functioning in the identical mode of operation (i.e. software and so on) as on the date of the test. Any deviation from the test conditions and the environment on the date of the test may result in measurement repeatability difficulties.

All changes made to the EUT during the course of testing as identified in this test report must be incorporated into the EUT or identical models to ensure compliance with the FCC regulations.



C. L. Payne III (Para. 1.1)
Facility Manager
Coalville Facility.
DNB Engineering, Inc.
Tel. (435) 336-4433
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1.3 Test Equipment List

TEST EQUIPMENT LIST - CONDUCTED EMISSIONS					
Description	Manufacturer	Model No.	Asset #	Serial #	Cal Due
LISN	Fisher Custom Communications	FCCLISN5032401	U-286	2020	03 Feb 2021
Spectrum Analyzer	Rhode & Schwarz	FSV30	U-248	101367	17 Aug 2020
TILE Software	ETS Lindgren	3.4.11.13	U-317	8112006	07 Mar 2021

TEST EQUIPMENT LIST - RADIATED EMISSIONS					
Description	Manufacturer	Model No.	Asset #	Serial #	Cal Due
Pre-Amplifier	Hewlett Packard	8447D	U-068	2727A06184	04 Aug 2020
Pre-Amplifier	DNB	S-21G	U-095	U-095-1	03 Feb 2021
DRG Horn Antenna	AH Systems	SAS-571	U-071	417	11 Jul 2020
Spectrum Analyzer	Rhode & Schwarz	FSV30	U-248	101367	17 Aug 2020
TILE Software	ETS- Lindgern	3.4.11.13	U-317	8112006	07 Mar 2021

TEST EQUIPMENT LIST - ANTENNA CONDUCTED					
Description	Manufacturer	Model No.	Asset #	Serial #	Cal Due
Spectrum Analyzer	Rhode & Schwarz	FSV30	U-248	101367	17 Aug 2020

1.4 Test Summary Cross Reference

Test Item	FCC Requirement	IC Requirement	Test Method	Result
Antenna Requirement	15.203/15.247	RSS-Gen 6.8	---	Pass
Conducted Emissions (General Provisions)	15.207	RSS-Gen 8.8	ANSI C63.10-2013	Pass
Radiated Emissions (General Provisions)	15.209	RSS-Gen 8.9	ANSI C63.10-2013	Pass
Carrier Frequency Separation	15.247 (a,1)	RSS-247 5.1 a)	ANSI C63.10-2013 Clause 7.8.2	Pass
Number of Hopping Frequencies	15.247 (a,1,i)	RSS-247 5.1 c)	ANSI C63.10-2013 Clause 7.8.3	Pass
Time of Occupancy (Dwell Time)	15.247 (a,1,i)	RSS-247 5.1 c)	ANSI C63.10-2013 Clause 7.8.4	Pass
Pseudorandom Frequency Hopping Sequence	15.247 (a,1,i)	RSS-247 5.1 c)	KDB55807 (9,c,1,i)	Pass
Equal Hopping Frequency Use	15.247 (a,1,i)	RSS-247 5.1 c)	KDB55807 (9,c,1,ii)	Pass
System Receiver Input Bandwidth	15.247 (a,1,i)	RSS-247 5.1 c)	KDB55807 (9,c,1,iii)	Pass
System Receiver Hopping Capability	15.247 (a,1,i)	RSS-247 5.1 c)	KDB55807 (9,c,1,iv)	Pass
Output Power (FHSS)	15.247 (b,2)	RSS-247 5.4 a)	ANSI C63.10-2013 Clause 7.8.5	Pass
Band-edge RF Conducted	15.247 (d)	RSS-247 5.4 a)	ANSI C63.10-2013 Clause 7.8.6	Pass
Occupied Bandwidth	15.247 (a,1,i)	RSS-247 5.1 c)	ANSI C63.10-2013 Clause 7.8.7	Pass
Conducted Spurious	15.247 (d)	RSS-247 5.5	ANSI C63.10-2013 Clause 7.8.8	Pass
Radiated Spurious Emissions	15.247 (d)	RSS-247 5.5	ANSI C63.10-2013 Clause 11.12.2.7	Pass
Restricted Bands	15.247 (d)	RSS-Gen 8.10	ANSI C63.10-2013 Clause 11.12.2	Pass
Short Burst Systems	15.247 (g)	---	KDB 558074 (9,c,2)	Pass
Coordination with other FHSS Systems	15.247 (h)	---	KDB 558074 (9,c,3)	Pass

RSS-GEN Issue 5 Mar 2019
 RSS-247 Issue 2 Feb 2017

Preliminary scans were performed to determine worst case modulation, packet length, and data rates. Only worst case data has been recorded within the body of the test report.

1.5 Measurement Uncertainty

Measurement Type	Uncertainty
AC Conducted Emissions	± 1.67 dB
OATS - Radiated Emissions - Vertical Biconical (30-300MHz)	± 4.17 dB
OATS - Radiated Emissions - Horizontal Biconical (30-300MHz)	± 4.22 dB
OATS - Radiated Emissions - Vertical Log Periodic (300-100MHz)	± 4.92 dB
OATS - Radiated Emissions - Horizontal Log Periodic (300-1000MHz)	± 4.79 dB
OATS - Radiated Emissions - Vertical DRG Horn (> 1GHz)	± 5.74 dB
OATS - Radiated Emissions - Horizontal DRG Horn (>1GHz)	± 5.80 dB
Antenna Conducted Measurements	± 1.96 dB

2.1033 (b) (1) Application for Certification

Name of Applicant: Vutiliti Inc.
126 W. Sego Lily Drive, Suite 150
Sandy, UT 84070

FRN Number: 0027379361

Name of Manufacturer : Vutiliti Inc.
126 W. Sego Lily Drive, Suite 150
Sandy, UT 84070

Description: Limited Modular Transmitter LoRa (FHSS)

Model Number(s): VUHDC1

Anticipated Production Quantity: Multiple Units

Frequency Band: LoRa 125kHz (FHSS) 902.3 - 914.9 MHz

Rated Power: LoRa 125kHz (FHSS) 15.55dBm (36mW)

Type of Signal: LoRa 125kHz (FHSS)

Channels: LoRa 125kHz (FHSS) 64 Channels

Max Data Rate: 27kbps - Data transmission is not continuous, it happens for short intervals for short periods of time.

Antenna Type: External - Monopole

Antenna Gain: 2dBi

2.1033 (b,2) FCC Identifier

Model Number: VUHDC1
FCC ID: 2APCG-VUHDC1

The FCC ID is placed on the exterior surface of a plastic shell which covers the module and after insertion into the Vutiliti Host Device is still visible per FCC Module Label Guidelines.

Furthermore, both the module and the “host” are under the complete control of the grantee (Vutiliti).

The module is not sold to any third party or OEM manufacturer and is never outside the complete control of the Grantee (Vutiliti).

Photograph below shows the FCC ID placement.



2.1033 (b,3)	Installation and Operating Instructions -	Supplied separately.
2.1033 (b,4)	Brief Description of Circuit Function -	Supplied separately.
2.1033 (b,5)	Block Diagram -	Supplied separately.
2.1033 (b,7)	Equipment Photographs -	Supplied separately.

2.1033 (b,6) Report of Measurements

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

Pass - Antenna gain is equal to or less than 2dBi

Pass - Module is limited to Grantee's own products and not intended for sale to third parties, antennas are supplied by the grantee and are professionally installed by grantee in end use products at the time of manufacture.

Antenna is limited to one of the following two antennas:

Dongguan Haonuo Electronic Co Ltd
Bondale Electronics Ltd

P/n: HN0915-57C01SM
P/n: G-RA0K11165091-Q0011

Test Procedure: As specified in ANSI C63.10-2013

To measure conducted emissions, the EUT was set upon a wooden table in the shielded enclosure. AC power was fed into the EUT from the Artificial Mains Network. With the Artificial Mains Network connected to an Rhode & Schwarz FSV Signal and Spectrum Analyzer, and using Personal Computer with TILES Measurement Software, the spectrum was searched from 0.15 - 30 MHz for emissions emanating from the EUT.

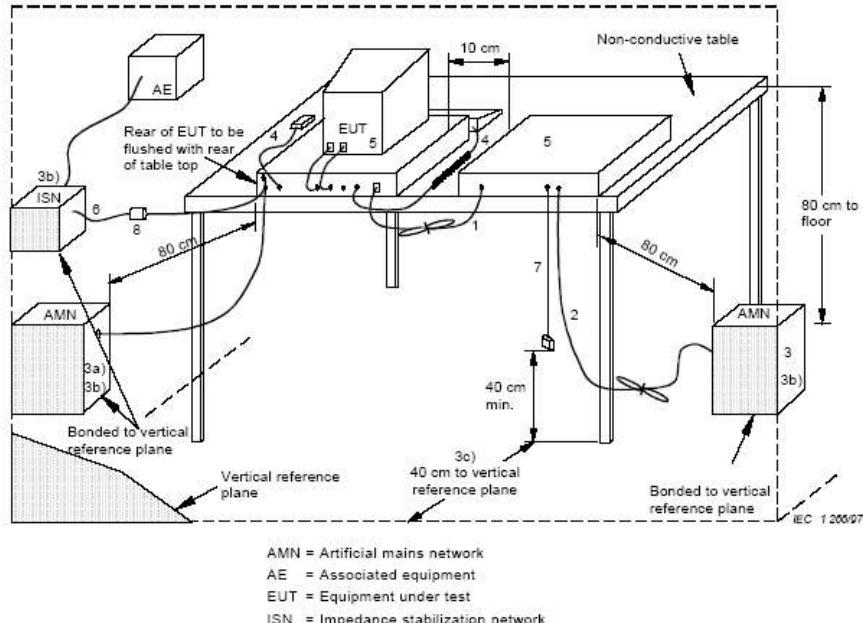
Frequency of emission (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 - 0.5	66 to 56*	56 to 46*
0.5 - 5	56	46
5 - 30	60	50

* Decreases with the logarithm of the frequency.

EUT operating conditions:

The software provided by the client to enable the EUT to transmit continuously.

Test Set Up:





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Conducted Emissions

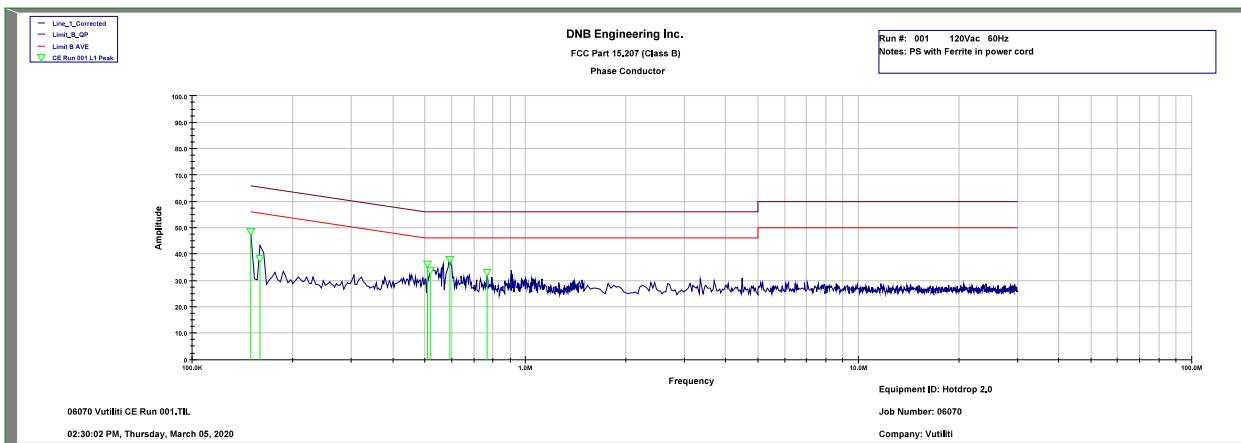
DNB Job Number:	06070	Date:	5 Mar 2020	Specification
Customer:	Vutiliti Inc.			[X] 15.207
Model Number:	VUHDC1			[X] ANSI C63.10-2013
Description:	Limited Modular Transmitter			
	Power supply as supplied from manufacturer (w/ferrite)			

EUT is in conformance with FCC 15.207 YES NO Signed

Y Staples

CONDUCTED EMISSIONS

Freq in MHz	Meter Reading dBuV	Factors in dB		Corr'd Reading dBuV	Limit		Lead	Measure Type	Delta dB
		LISN	Cable		dBuV	Type			
0.150	48.40	0.0	0.1	48.54	56.00	AVE	Phase	Peak	-7.46
0.160	38.00	0.0	0.1	38.15	55.71	AVE	Phase	Peak	-17.56
0.508	36.00	0.1	0.0	36.10	46.00	AVE	Phase	Peak	-9.90
0.517	33.70	0.1	0.0	33.80	46.00	AVE	Phase	Peak	-12.20
0.595	38.00	0.1	0.0	38.10	46.00	AVE	Phase	Peak	-7.90
0.767	33.00	0.1	0.0	33.10	46.00	AVE	Phase	Peak	-12.90





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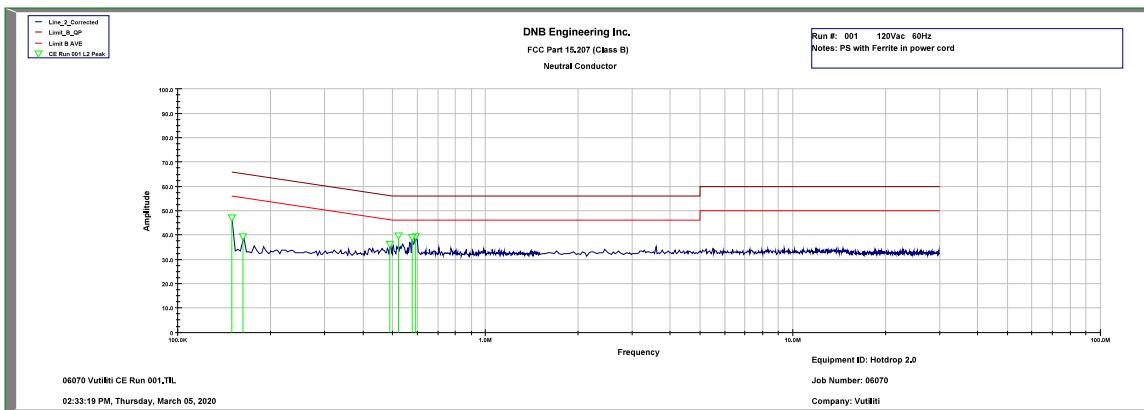
Conducted Emissions

DNB Job Number:	06070	Date:	5 Mar 2020	Specification
Customer:	Vutiliti Inc.			[X] 15.207
Model Number:	VUHDC1			[X] ANSI C63.10-2013
Description:	Limited Modular Transmitter			
	Power supply as supplied from manufacturer (w/ferrite)			

EUT is in conformance with FCC 15.207 YES NO Signed *Y Staples*

CONDUCTED EMISSIONS

Freq in MHz	Meter Reading dBuV	Factors in dB		Corr'd Reading dBuV	Limit		Lead	Measure Type	Delta dB
		LISN	Cable		dBuV	Type			
0.150	47.00	0.0	0.1	47.14	56.00	AVE	Neutral	Peak	-8.86
0.163	39.00	0.0	0.1	39.15	55.63	AVE	Neutral	Peak	-16.48
0.490	36.10	0.1	0.0	36.20	46.29	AVE	Neutral	Peak	-10.09
0.521	39.60	0.1	0.0	39.70	46.00	AVE	Neutral	Peak	-6.30
0.578	38.90	0.1	0.0	39.00	46.00	AVE	Neutral	Peak	-7.00
0.595	39.20	0.1	0.0	39.30	46.00	AVE	Neutral	Peak	-6.70





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Conducted Emissions

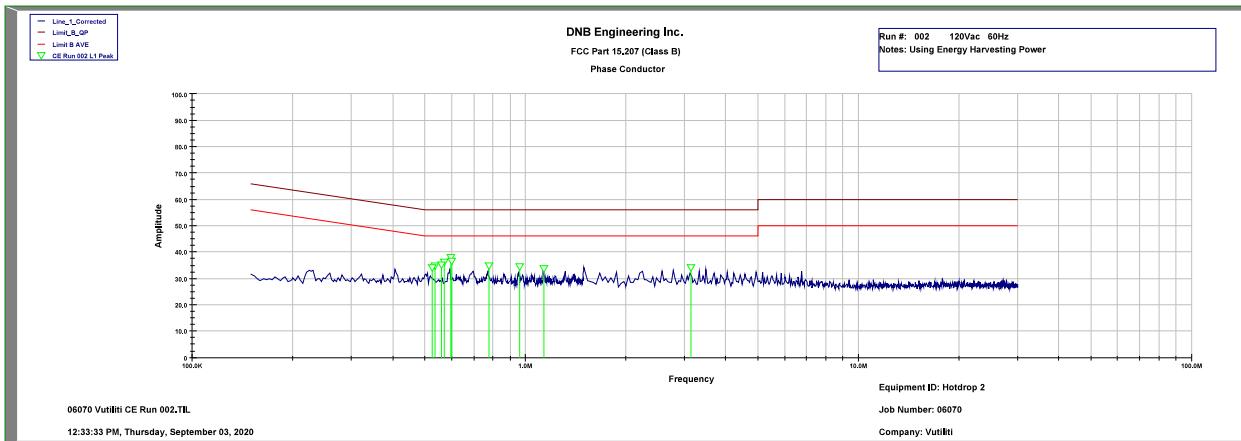
DNB Job Number:	06070	Date:	3 Sep 2020	Specification
Customer:	Vutiliti Inc.			[X] 15.207
Model Number:	VUHDC1			[X] ANSI C63.10-2013
Description:	Limited Modular Transmitter			
	Powered using energy harvesting method (Clamp-on)			

EUT is in conformance with FCC 15.207 YES NO Signed

CL Payne

CONDUCTED EMISSIONS

Freq in MHz	Meter Reading dBuV	Factors in dB		Corr'd Reading dBuV	Limit		Lead	Measure Type	Delta dB
		LISN	Cable		dBuV	Type			
0.525	33.82	0.1	0.0	33.94	46.0	AVE	L1	Peak	-12.06
0.535	34.69	0.1	0.0	34.80	46.0	AVE	L1	Peak	-11.20
0.562	34.88	0.1	0.0	35.00	46.0	AVE	L1	Peak	-11.00
0.572	36.00	0.1	0.0	36.12	46.0	AVE	L1	Peak	-9.88
0.596	37.94	0.1	0.0	38.06	46.0	AVE	L1	Peak	-7.94
0.602	36.47	0.1	0.0	36.59	46.0	AVE	L1	Peak	-9.41
0.778	34.56	0.1	0.0	34.70	46.0	AVE	L1	Peak	-11.30
0.960	34.34	0.1	0.1	34.53	46.0	AVE	L1	Peak	-11.47
1.140	33.54	0.1	0.1	33.76	46.0	AVE	L1	Peak	-12.24
3.150	33.49	0.1	0.4	33.97	46.0	AVE	L1	Peak	-12.03





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Conducted Emissions

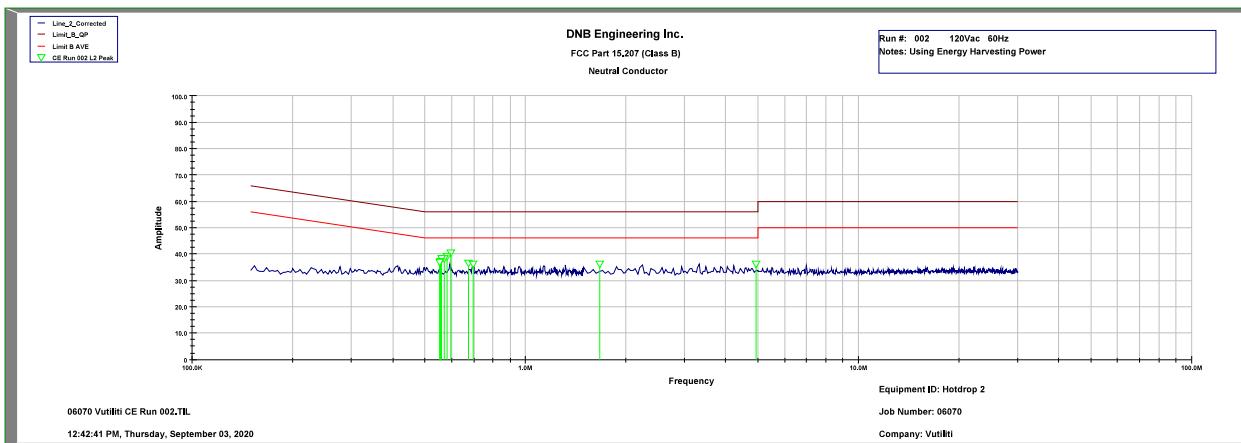
DNB Job Number:	06070	Date:	3 Sep 2020	Specification
Customer:	Vutiliti Inc.			[X] 15.207
Model Number:	VUHDC1			[X] ANSI C63.10-2013
Description:	Limited Modular Transmitter			
	Powered using energy harvesting method (Clamp-on)			

EUT is in conformance with FCC 15.207 YES NO Signed

CL Payne

CONDUCTED EMISSIONS

Freq in MHz	Meter Reading dBuV	Factors in dB		Corr'd Reading dBuV	Limit		Lead	Measure Type	Delta dB
		LISN	Cable		dBuV	Type			
0.552	36.95	0.1	0.0	37.07	46.0	AVE	L2	Peak	-8.94
0.555	37.00	0.1	0.0	37.12	46.0	AVE	L2	Peak	-8.88
0.558	38.13	0.1	0.0	38.25	46.0	AVE	L2	Peak	-7.75
0.572	38.36	0.1	0.0	38.48	46.0	AVE	L2	Peak	-7.52
0.582	38.90	0.1	0.0	39.02	46.0	AVE	L2	Peak	-6.98
0.596	40.48	0.1	0.0	40.60	46.0	AVE	L2	Peak	-5.40
0.673	36.40	0.1	0.0	36.53	46.0	AVE	L2	Peak	-9.47
0.697	36.23	0.1	0.0	36.36	46.0	AVE	L2	Peak	-9.64
1.670	35.76	0.1	0.2	36.09	46.0	AVE	L2	Peak	-9.91
4.940	35.67	0.1	0.5	36.26	46.0	AVE	L2	Peak	-9.74





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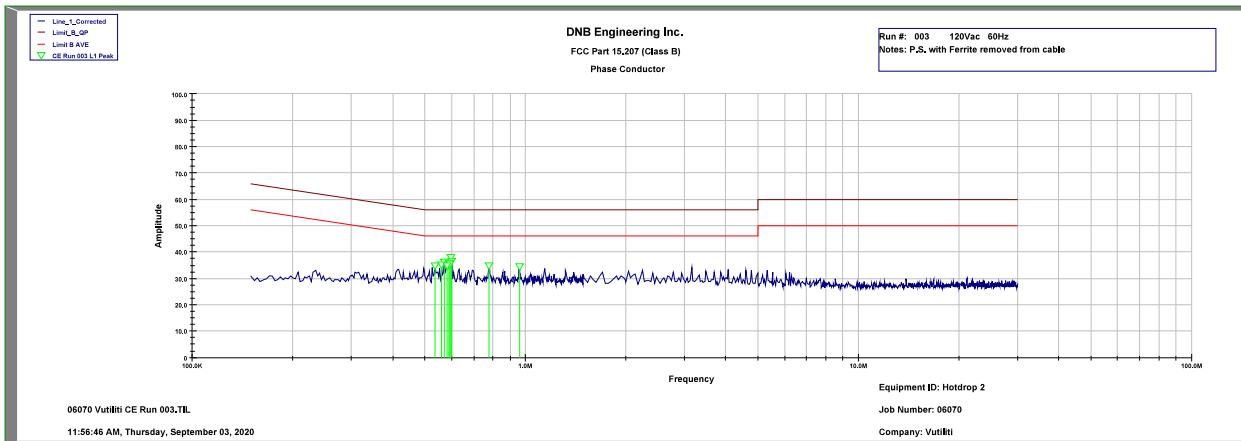
Conducted Emissions

DNB Job Number:	06070	Date:	3 Sep 2020	Specification
Customer:	Vutiliti Inc.			[X] 15.207
Model Number:	VUHDC1			[X] ANSI C63.10-2013
Description:	Limited Modular Transmitter			
	With ferrite removed from power cord			

EUT is in conformance with FCC 15.207 YES NO Signed *CL Payne*

CONDUCTED EMISSIONS

Freq in MHz	Meter Reading dBuV	Factors in dB		Corr'd Reading dBuV	Limit		Lead	Measure Type	Delta dB
		LISN	Cable		dBuV	Type			
0.535	34.69	0.0	0.1	34.80	46.0	AVE	L1	Peak	-11.20
0.562	34.88	0.0	0.1	35.00	46.0	AVE	L1	Peak	-11.00
0.572	36.00	0.0	0.1	36.12	46.0	AVE	L1	Peak	-9.88
0.582	34.62	0.0	0.1	34.74	46.0	AVE	L1	Peak	-11.26
0.589	35.83	0.0	0.1	35.95	46.0	AVE	L1	Peak	-10.05
0.592	35.47	0.0	0.1	35.59	46.0	AVE	L1	Peak	-10.41
0.596	37.94	0.0	0.1	38.06	46.0	AVE	L1	Peak	-7.94
0.602	36.47	0.0	0.1	36.59	46.0	AVE	L1	Peak	-9.41
0.778	34.56	0.0	0.1	34.70	46.0	AVE	L1	Peak	-11.30
0.960	34.34	0.1	0.2	34.53	46.0	AVE	L1	Peak	-11.47





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Conducted Emissions

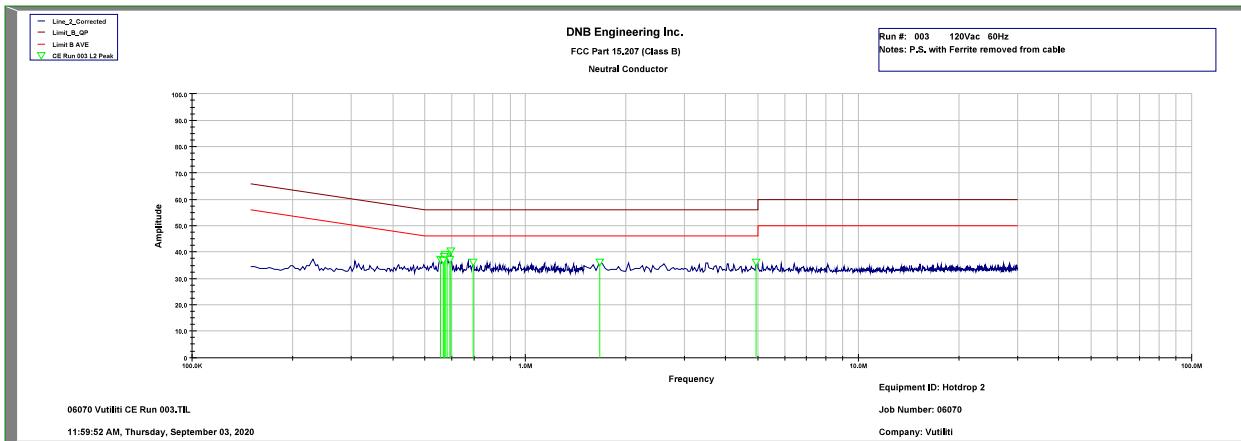
DNB Job Number:	06070	Date:	3 Sep 2020	Specification
Customer:	Vutiliti Inc.			[X] 15.207
Model Number:	VUHDC1			[X] ANSI C63.10-2013
Description:	Limited Modular Transmitter			
	With ferrite removed from power cord			

EUT is in conformance with FCC 15.207 YES NO Signed

CL Payne

CONDUCTED EMISSIONS

Freq in MHz	Meter Reading dBuV	Factors in dB		Corr'd Reading dBuV	Limit		Lead	Measure Type	Delta dB
		LISN	Cable		dBuV	Type			
0.555	37.00	0.0	0.1	37.12	46.0	AVE	L2	Peak	-8.88
0.569	36.88	0.0	0.1	37.00	46.0	AVE	L2	Peak	-9.00
0.572	38.36	0.0	0.1	38.48	46.0	AVE	L2	Peak	-7.52
0.575	38.80	0.0	0.1	38.92	46.0	AVE	L2	Peak	-7.08
0.582	38.90	0.0	0.1	39.02	46.0	AVE	L2	Peak	-6.98
0.592	37.10	0.0	0.1	37.22	46.0	AVE	L2	Peak	-8.78
0.596	40.48	0.0	0.1	40.60	46.0	AVE	L2	Peak	-5.40
0.697	36.23	0.0	0.1	36.36	46.0	AVE	L2	Peak	-9.64
1.670	35.76	0.2	0.3	36.09	46.0	AVE	L2	Peak	-9.91
4.940	35.67	0.5	0.6	36.26	46.0	AVE	L2	Peak	-9.74



Test Procedure: ANSI C63.10-2013

The EUT was measured on an open area test site (OATS).

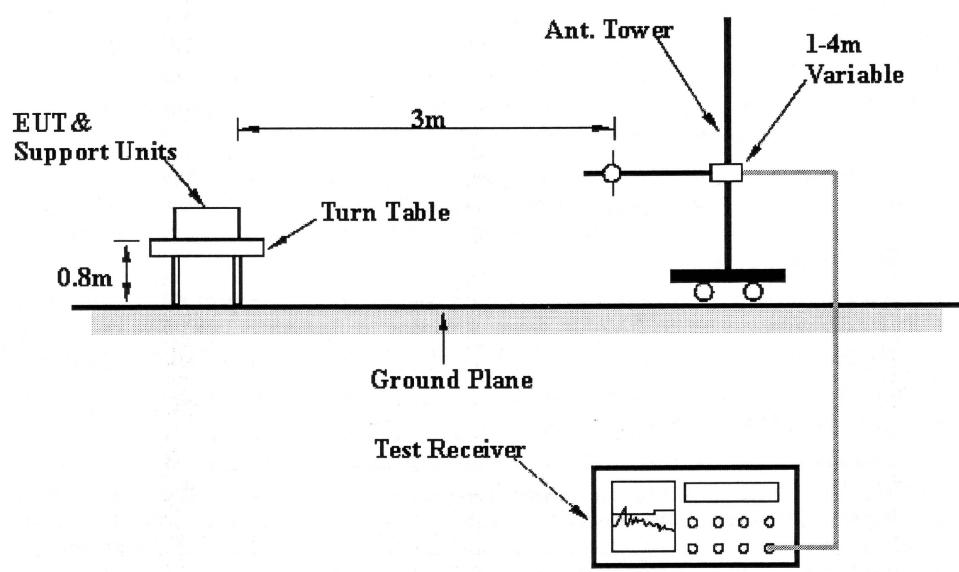
A measuring distance of at least 3 m shall be used for measurements at frequencies up to 1 GHz. For frequencies above 1 GHz, any suitable measuring distance may be used. The equipment size (excluding the antenna) shall be less than 20 % of the measuring distance.

Sufficient precautions shall be taken to ensure that reflections from extraneous objects adjacent to the site do not degrade the measurement results, in particular:

- no extraneous conducting objects having any dimension in excess of a quarter wavelength of the highest frequency tested shall be in the immediate vicinity of the site;
- all cables shall be as short as possible; as much of the cables as possible shall be on the ground plane or preferably below; and the low impedance cables shall be screened.
- EUT was positioned in three orthogonal axis - only the worst case data (X-Axis) has been recorded

The EUT shall be placed upon a non-conductive table (wooden for below 1GHz and styrene above 1GHz) 0.80 meters above the ground plane for frequencies from 30 to 1000MHz and 1.5 meters above the ground plane above 1 Ghz and shall be placed in the “worst case” transmitting mode. The EUT shall be rotated 360 degrees to find the azimuth maxima. The receive antenna shall then be raised and lowered between 1 to 4 meters to find the maximum signal emanating from the EUT. This signal strength is then recorded on the data sheets.

Frequency (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measurement Distance (meters)
.0009 - 0.490	2400/F(kHz)	$20*(\log_{10}(2400/F(kHz)))$	300
0.490 - 1.705	24000/F(kHz)	$20*(\log_{10}(24000/F(kHz)))$	30
1.705 - 30.0	30	29.5	30
30 - 88	100	40.0	3
88 - 216	150	43.5	3
216 - 960	200	46.0	3
Above 960	500	54.0	3





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Radiated Emissions (General)

DNB Job Number:	06070	Date:	4 Mar 2020	Specification [X] 15.209 [X] ANSI C63.10-2013	
Customer:	Vutiliti Inc.				
Model Number:	VUHDC1				
Description:	Limited Modular Transmitter				

EUT is in conformance with FCC 15.209 YES NO Signed *Y Staples*

X - Axis

FREQ (Mhz)	S/A Reading (dBuV/m)	Correction Factors (dB)			dBuV/m			Positions			
		Ant	Cbl	Amp	Corr	Lim	Delta	Typ	Tbl	Pl	Hgt
30.838	19.58	19.43	1.23	26.30	13.94	40.0	-26.06	QP	0	Horz	4.00
33.558	19.46	17.91	1.34	26.30	12.41	40.0	-27.60	QP	0	Horz	4.00
36.478	19.89	16.30	1.43	26.27	11.35	40.0	-28.66	QP	0	Horz	4.00
54.644	34.22	10.65	1.69	26.15	20.41	40.0	-19.59	QP	67	Vert	1.00
62.830	33.95	10.77	1.83	26.10	20.45	40.0	-19.56	QP	214	Vert	1.00
64.600	32.30	10.88	1.85	26.10	18.92	40.0	-21.09	QP	214	Vert	1.00
128.280	35.56	11.85	2.57	25.96	24.02	43.5	-19.49	QP	158	Vert	1.00
129.210	34.47	11.88	2.58	25.95	22.98	43.5	-20.53	QP	158	Vert	1.00
169.979	29.30	14.50	3.25	25.80	21.25	43.5	-22.26	QP	0	Vert	1.05
746.400	33.05	27.60	7.62	27.01	41.27	46.0	-4.74	QP	108	Vert	4.00



1100 E Chalk Creek Road
Coalville, UT 84017
(435) 336-4433
FAX (435) 336-4436

Radiated Emissions (General)

DNB Job Number:	06070	Date:	4 Mar 2020	Specification [X] 15.209 [X] ANSI C63.10-2013	
Customer:	Vutiliti Inc.				
Model Number:	VUHDC1				
Description:	Limited Modular Transmitter				

EUT is in conformance with FCC 15.209 YES NO Signed *Y Staples*

Y - Axis

FREQ (Mhz)	S/A Reading (dBuV/m)	Correction Factors (dB)			dBuV/m			Positions			
		Ant	Cbl	Amp	Corr	Lim	Delta	Typ	Tbl	Pl	Hgt
127.808	17.94	11.83	2.56	25.96	6.37	43.5	-37.14	QP	0	Horz	4.00
135.620	17.72	12.07	2.71	25.92	6.58	43.5	-36.93	QP	0	Horz	4.00
170.072	17.25	14.50	3.25	25.80	9.20	43.5	-34.31	QP	0	Horz	4.00
54.680	34.98	10.65	1.69	26.15	21.17	40.0	-18.83	QP	292	Vert	1.00
63.200	34.22	10.79	1.83	26.10	20.74	40.0	-19.26	QP	147	Vert	1.00
126.525	32.03	11.80	2.53	25.97	20.39	43.5	-23.12	QP	154	Vert	1.00
128.630	33.45	11.86	2.57	25.96	21.92	43.5	-21.58	QP	152	Vert	1.00
170.002	29.00	14.50	3.25	25.80	20.95	43.5	-22.56	QP	0	Vert	1.10
746.400	32.60	27.60	7.62	27.01	40.82	46.0	-5.19	QP	112	Vert	4.00



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Radiated Emissions (General)

DNB Job Number:	06070	Date:	4 Mar 2020	Specification [X] 15.209 [X] ANSI C63.10-2013	
Customer:	Vutiliti Inc.				
Model Number:	VUHDC1				
Description:	Limited Modular Transmitter				

EUT is in conformance with FCC 15.209 YES NO Signed *Y Staples*

Z - Axis

FREQ (Mhz)	S/A Reading	Correction Factors (dB)			dBuV/m			Positions			
		Ant	Cbl	Amp	Corr	Lim	Delta	Typ	Tbl	Pl	Hgt
170.273	34.98	14.49	3.25	25.80	26.92	43.5	-16.59	QP	0	Horz	4.00
746.355	26.30	27.60	7.62	27.01	34.52	46.0	-11.49	QP	285	Horz	3.07
54.547	36.27	10.65	1.69	26.15	22.46	40.0	-17.55	QP	221	Vert	1.00
61.970	35.37	10.72	1.82	26.10	21.81	40.0	-18.20	QP	81	Vert	1.00
82.480	27.96	10.92	2.10	26.00	14.98	40.0	-25.02	QP	205	Vert	1.00
126.410	34.20	11.79	2.53	25.97	22.55	43.5	-20.96	QP	139	Vert	1.00
128.260	31.99	11.85	2.57	25.96	20.44	43.5	-23.06	QP	139	Vert	1.00
170.002	28.70	14.50	3.25	25.80	20.65	43.5	-22.86	QP	0	Vert	1.17
746.379	31.55	27.60	7.62	27.01	39.77	46.0	-6.24	QP	172	Vert	4.00

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- a) Span: Wide enough to capture the peaks of two adjacent channels.
- b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
- c) Video (or average) bandwidth (VBW) \geq RBW.
- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.
- g) Allow the trace to stabilize.

Use the marker-delta function to determine the separation between the peaks of the adjacent channels. Compliance of an EUT with the appropriate regulatory limit shall be determined. A plot of the data shall be included in the test report.

Requirement: FCC Part 15.247 Clause (a,1)

15.247 Operation within the bands 902-928 MHz.

- (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
 - (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Limit = 20dB bandwidth = 163kHz

Client: Vutiliti

Date: 04 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

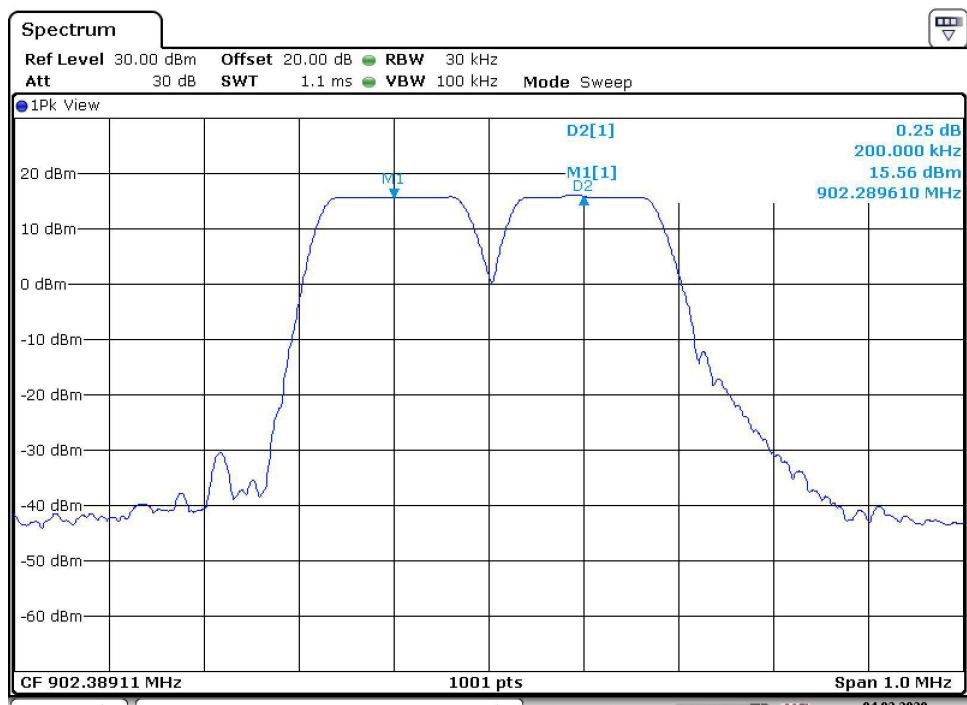
Model No: VUHDC1

Channel Separation = 200kHz

Tech: CL Payne

Requirement \geq 20dB bandwidth or 163kHz

Result: Pass



The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
- b) RBW: To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
- c) $VBW \geq RBW$.
- d) Sweep: Auto.
- e) Detector function: Peak.
- f) Trace: Max hold.
- g) Allow the trace to stabilize.

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

Requirement: FCC Part 15.247 Clause (a,1,i)

15.247 Operation within the bands 902-928 MHz.

- (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
 - (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
 - (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

Limit 20dB bandwidth is less than 250kHz therefore system shall use at least 50 hopping channels

Client: Vutiliti

Date: 25 Feb 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

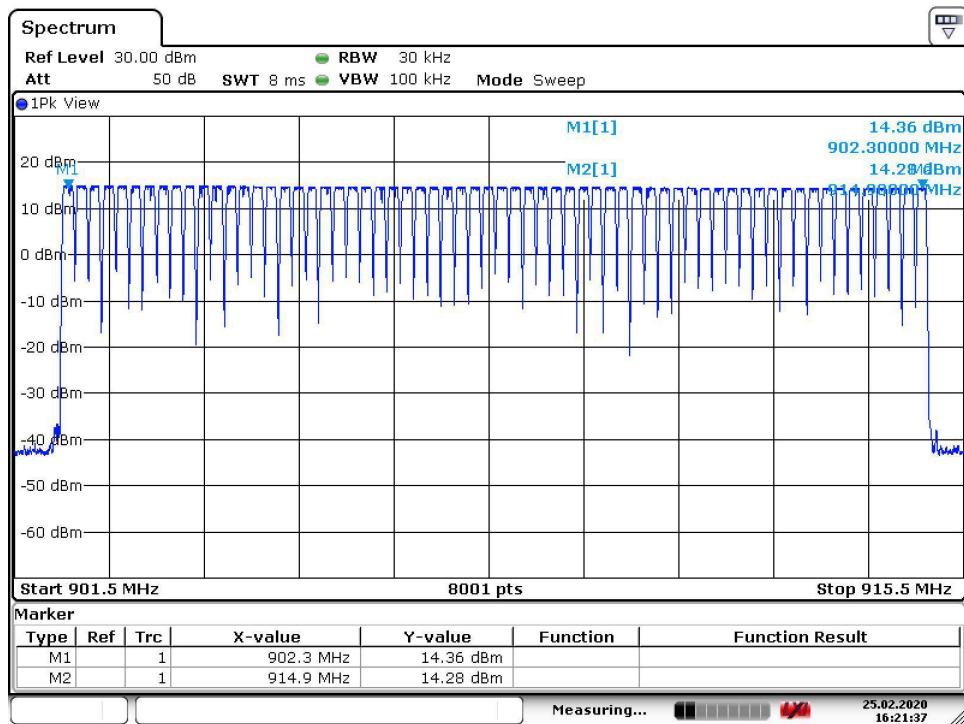
Model No: VUHDC1

Requirement > 50 Hopping Channels

Tech: CL Payne

Number of Hopping Channels = 64

Result: Pass



The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

- a) Span: Zero span, centered on a hopping channel.
- b) RBW shall be \leq channel spacing and where possible RBW should be set $>> 1 / T$, where T is the expected dwell time per channel.
- c) Sweep: As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
- d) Detector function: Peak.
- e) Trace: Max hold.

Use the marker-delta function to determine the transmit time per hop. If this value varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation in transmit time.

Repeat the measurement using a longer sweep time to determine the number of hops over the period specified in the requirements. The sweep time shall be equal to, or less than, the period specified in the requirements. Determine the number of hops over the sweep time and calculate the total number of hops in the period specified in the requirements, using the following equation:

$$\text{(Number of hops in the period specified in the requirements)} = \\ \text{(number of hops on spectrum analyzer)} \times \text{(period specified in the requirements / analyzer sweep time)}$$

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements. If the number of hops in a specific time varies with different modes of operation (data rate, modulation format, number of hopping channels, etc.), then repeat this test for each variation.

The measured transmit time and time between hops shall be consistent with the values described in the operational description for the EUT.

Requirement: FCC Part 15.247 Clause (a,1,i)

15.247 Operation within the bands 902-928 MHz.

- (a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
 - (1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.
 - (i) For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

Limit 0.4 seconds within a 20 second period

Client: Vutiliti

Date: 25 Feb 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

Requirement \leq 0.4 seconds within a 20 second period

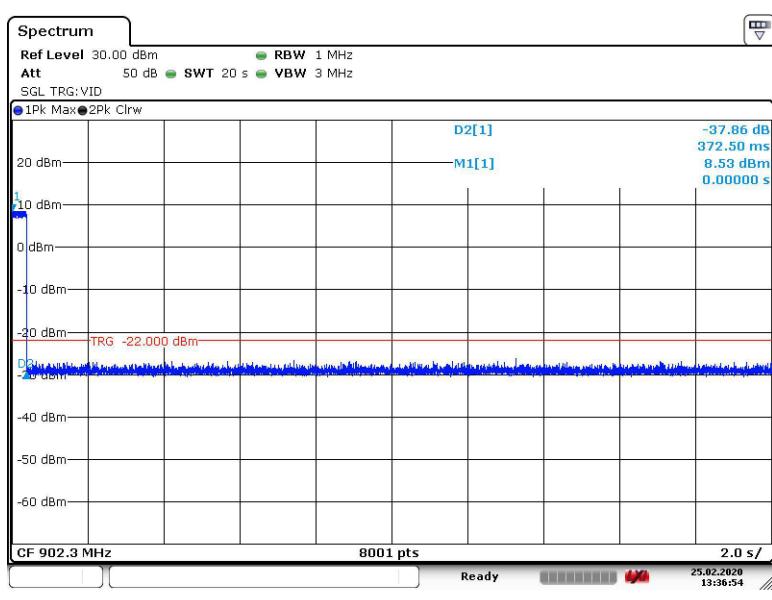
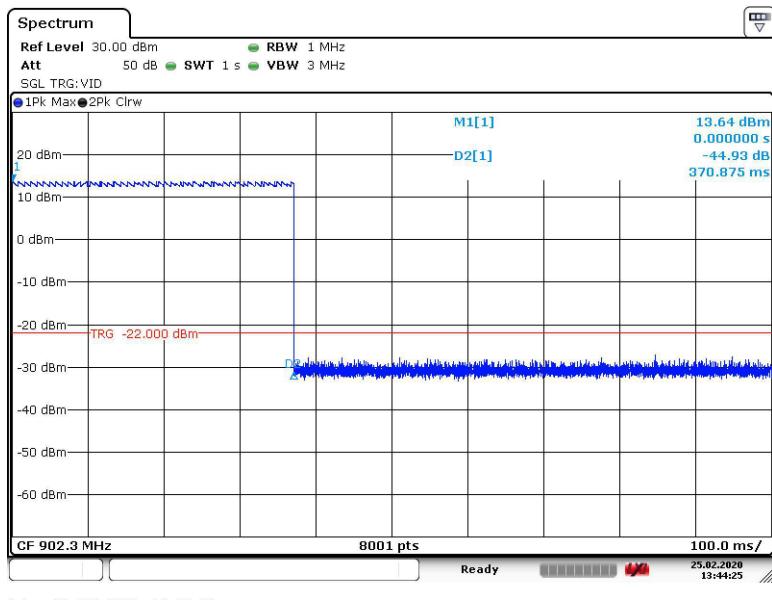
Tech: CL Payne

Duration of pulse = 0.371seconds

Result: Pass

Time to next pulse > 20 seconds

Result: Pass



15.247 (a,1,i) Pseudorandom Frequency Hopping Sequence KDB55807 (9,c,1,i)

Describe how the hopping sequence is generated. Provide an example of the hopping sequence channels, to demonstrate that the sequence meets the requirement specified in the definition of an FHSS system, found in Section 2.1(c). Per the definition in Section 2.1(c), the hop set shall appear as random in the near term, shall appear as evenly distributed in the long term, and sequential hops shall be randomly distributed in both direction and magnitude of change.

Provided in the Operational Description for Confidentiality

15.247 (a,1,i) Equal Hopping Frequency Use KDB55807 (9,c,1,ii)

Provided in the Operational Description for Confidentiality

15.247 (a,1,i) System Receiver Input Bandwidth KDB55807 (9,c,1,iii)

Describe how the associated receiver(s) complies with the requirement that the input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

Provided in the Operational Description for Confidentiality

15.247 (a,1,i) System Receiver Hopping Capability KDB55807 (9,c,1,iv)

Describe how the associated receiver(s) has the ability to shift frequencies in synchronization with the transmitted signals.

Provided in the Operational Description for Confidentiality

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

- a) Use the following spectrum analyzer settings:
 - 1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
 - 2) RBW > 20 dB bandwidth of the emission being measured.
 - 3) $VBW \geq RBW$.
 - 4) Sweep: Auto.
 - 5) Detector function: Peak.
 - 6) Trace: Max hold.
- b) Allow trace to stabilize.
- c) Use the marker-to-peak function to set the marker to the peak of the emission.
- d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
- e) A plot of the test results and setup description shall be included in the test report.

NOTE—A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

Requirement: FCC Part 15.247 Clause (b,2)

15.247 Operation within the bands 902-928 MHz.

- (b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
 - (2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Limit : System employs 64 hopping channels therefore limit = 1 watt or 30dBm

Client: Vutiliti

Date: 4 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

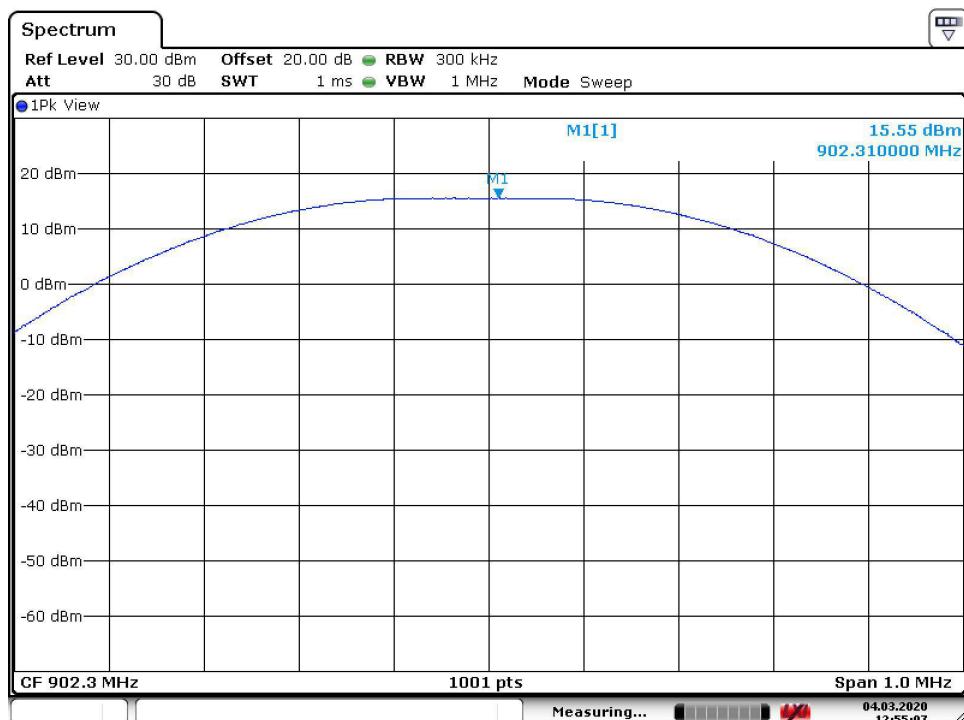
Requirement \leq 1 Watt or 30dBm

Tech: CL Payne

Low Channel: 902.3MHz

Power: 15.55dBm

Result: Pass



Client: Vutiliti

Date: 4 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

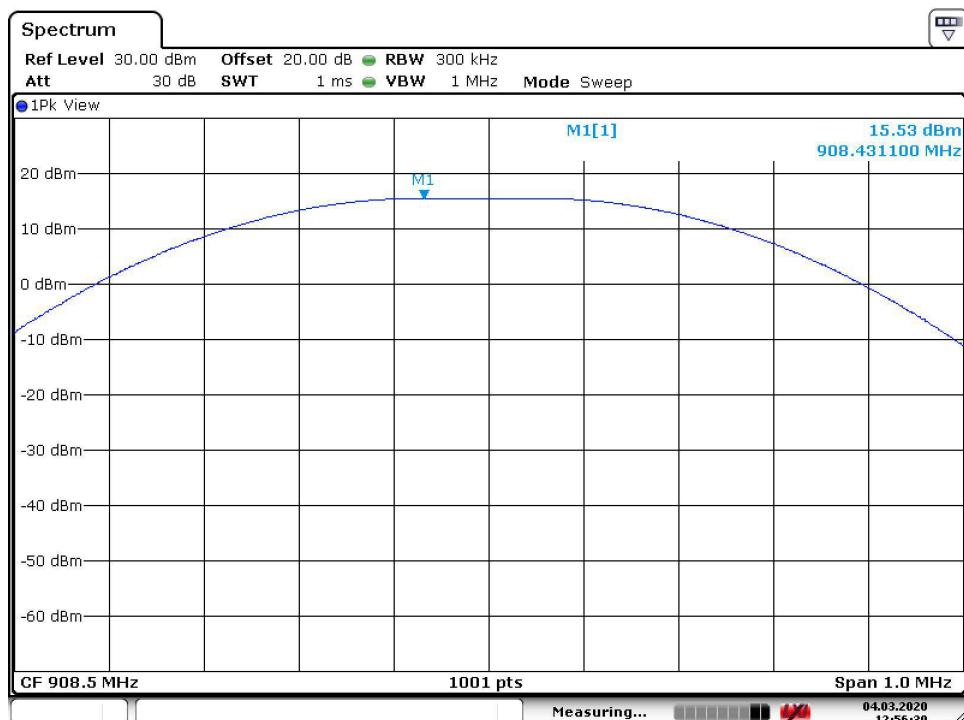
Requirement \leq 1 Watt or 30dBm

Tech: CL Payne

Mid Channel: 908.5MHz

Power: 15.53dBm

Result: Pass



Client: Vutiliti

Date: 4 Mar 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

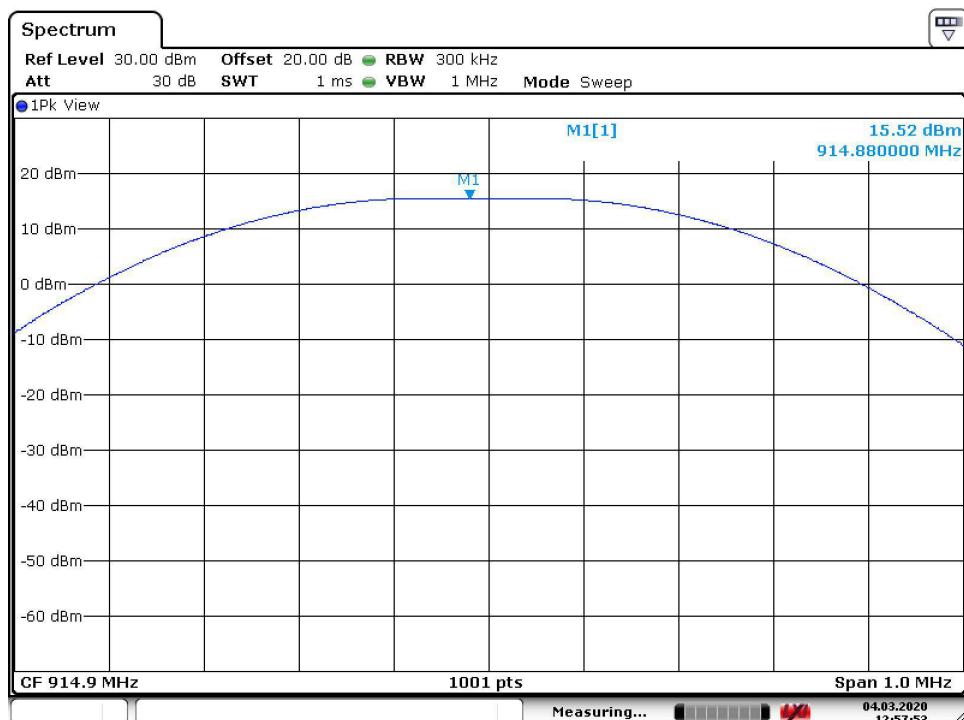
Requirement \leq 1 Watt or 30dBm

Tech: CL Payne

High Channel: 914.9MHz

Power: 15.52dBm

Result: Pass



For band-edge measurements, use the band-edge procedure in 6.10. Band-edge measurements shall be tested both on single channels, and with the EUT hopping.

6.10 Band-edge testing

The following procedure shall be used when band-edge measurements are required.

6.10.1 Band-edge data reporting requirements

These reporting requirements are applicable to all devices for which band-edge measurements are required. On each operating frequency measured, band-edge emissions shall be reported by providing plots of the measuring instrument display. The axes, the scale units per division, and the limit shall be clearly labeled in the test report. Tabular data are not suitable for reporting band-edge emissions.

6.10.4 Authorized-band band-edge measurements (relative method)

These procedures are applicable for determining compliance at authorized-band band-edges where the requirements are expressed as a value relative to the in-band signal level.

For devices that support frequency hopping, this test sequence shall be performed twice: once with the hopping function turned OFF and then repeated with the hopping function turned ON.

- a) Connect the EMI receiver or spectrum analyzer to the EUT using an appropriate RF cable connected to the EUT output. Configure the spectrum analyzer settings as described in step e) (be sure to enter all losses between the unlicensed wireless device output and the spectrum analyzer).
- b) Set the EUT to the lowest frequency channel (for the hopping on test, the hopping sequence shall include the lowest frequency channel).
- c) Set the EUT to operate at maximum output power and 100% duty cycle, or equivalent "normal mode of operation".
- d) Blank
- e) Perform the test as follows:
 - 1) Span: Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.

15.247 (d) Band-edge RF Conducted (continued)

- 2) Reference level: As required to keep the signal from exceeding the maximum instrument input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log (\text{OBW}/\text{RBW})]$ below the reference level. Specific guidance is given in 4.1.5.2.
- 3) Attenuation: Auto (at least 10 dB preferred).
- 4) Sweep time: Coupled.
- 5) Resolution bandwidth: 100 kHz
- 6) Video bandwidth: 300 kHz
- 7) Detector: Peak.
- 8) Trace: Max hold.

f) Allow the trace to stabilize. For the test with the hopping function turned ON, this can take several minutes to achieve a reasonable probability of intercepting any emissions due to oscillator overshoot.

g) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.

h) Repeat step c) through step e) for every applicable modulation.

i) Set the EUT to the highest frequency channel (for the hopping on test, the hopping sequence shall include the highest frequency channel) and repeat step c) through step d).

j) The band-edge measurement shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Requirement: FCC Part 15.247 Clause (d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

Client: Vutiliti

Date: 28 Feb 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

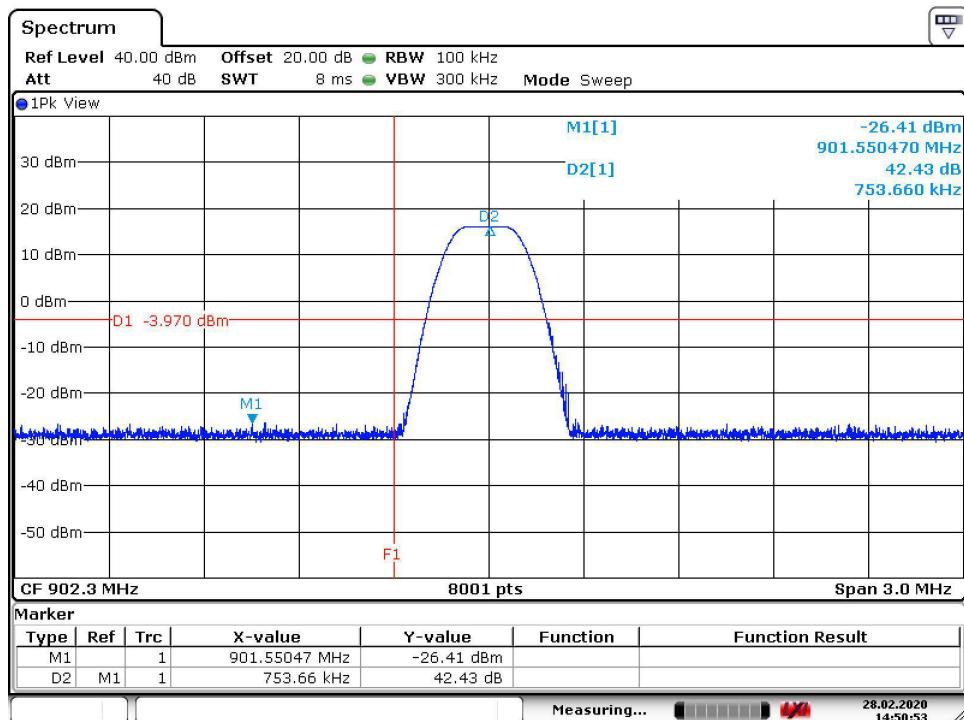
Requirement: Band-Edge Compliance (FHSS)

Tech: CL Payne

Low Channel: 902.3

Single Channel

Result: Pass



Client: Vutiliti

Date: 28 Feb 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

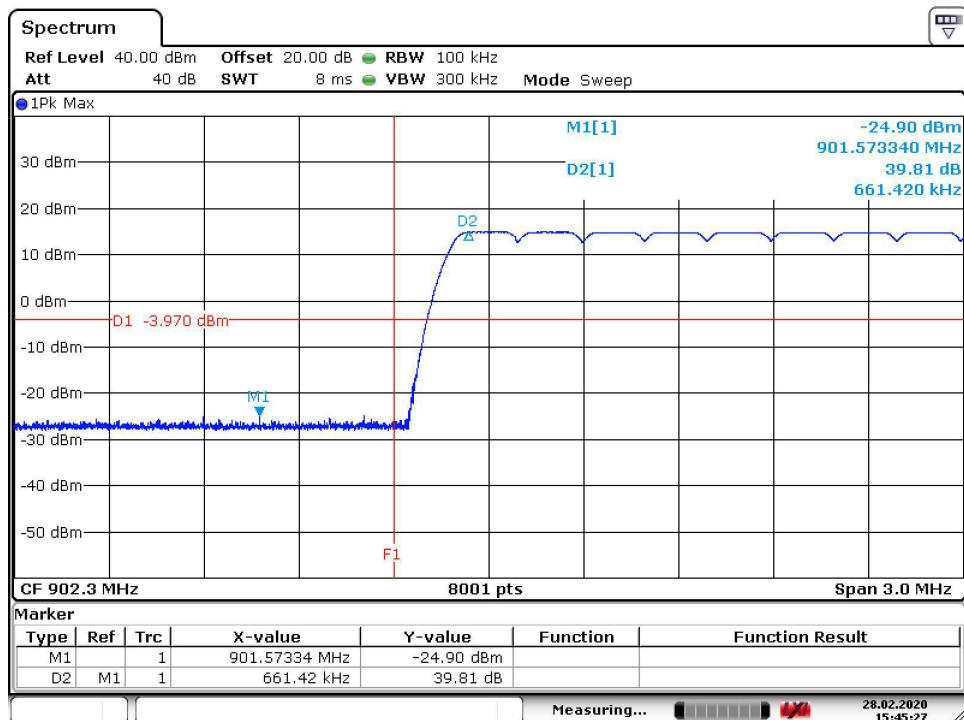
Requirement: Band-Edge Compliance (FHSS)

Tech: CL Payne

Low Channel: 902.3

All Channels Hopping

Result: Pass



Client: Vutiliti

Date: 28 Feb 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

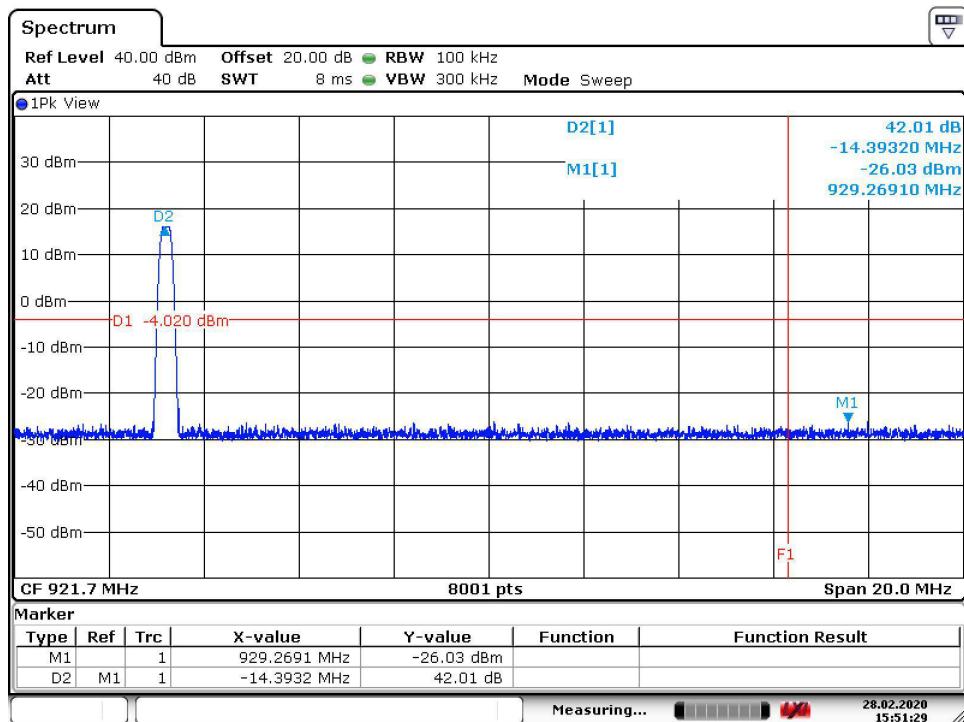
Requirement: Band-Edge Compliance (FHSS)

Tech: CL Payne

High Channel: 914.9

Single Channel

Result: Pass



Client: Vutiliti

Date: 28 Feb 2020

DNB Job: 06070

EUT: Limited Modular Transmitter LoRa (FHSS)

Model No: VUHDC1

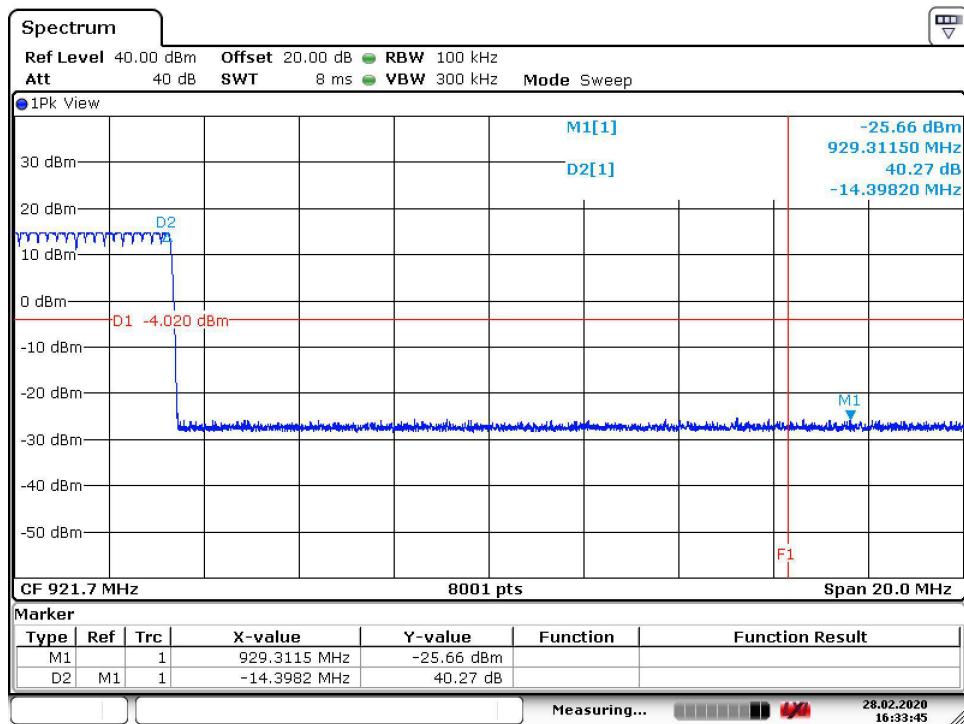
Requirement: Band-Edge Compliance (FHSS)

Tech: CL Payne

High Channel: 914.9

All Channels Hopping

Result: Pass



For occupied bandwidth measurements, use the procedure in 6.9.2.

6.9.2 Occupied bandwidth—relative measurement procedure

The occupied bandwidth is measured as the width of the spectral envelope of the modulated signal, at an amplitude level reduced from a reference value by a specified ratio (or in decibels, a specified number of dB down from the reference value). Typical ratios, expressed in dB, are –6 dB, –20 dB, and –26 dB, corresponding to 6 dB BW, 20 dB BW, and 26 dB BW, respectively. In this subclause, the ratio is designated by “–xx dB.” The reference value is either the level of the unmodulated carrier or the highest level of the spectral envelope of the modulated signal, as stated by the applicable requirement. Some requirements might specify a specific maximum or minimum value for the “–xx dB” bandwidth; other requirements might specify that the “–xx dB” bandwidth be entirely contained within the authorized or designated frequency band.

- a) The spectrum analyzer center frequency is set to the nominal EUT channel center frequency. The span range for the EMI receiver or spectrum analyzer shall be between two times and five times the OBW.
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than $[10 \log (\text{OBW}/\text{RBW})]$ below the reference level. Specific guidance is given in 4.1.5.2.
- d) Steps a) through c) might require iteration to adjust within the specified tolerances.
- e) The dynamic range of the instrument at the selected RBW shall be more than 10 dB below the target “–xx dB down” requirement; that is, if the requirement calls for measuring the –20 dB OBW, the instrument noise floor at the selected RBW shall be at least 30 dB below the reference value.
- f) Set detection mode to peak and trace mode to max hold.
- g) Determine the reference value: Set the EUT to transmit an unmodulated carrier or modulated signal, as applicable. Allow the trace to stabilize. Set the spectrum analyzer marker to the highest level of the displayed trace (this is the reference value).
- h) Determine the “–xx dB down amplitude” using $[(\text{reference value}) - \text{xx}]$. Alternatively, this calculation may be made by using the marker-delta function of the instrument.

15.247 (a,1,i) Occupied Bandwidth - continued

- i) If the reference value is determined by an unmodulated carrier, then turn the EUT modulation ON, and either clear the existing trace or start a new trace on the spectrum analyzer and allow the new trace to stabilize. Otherwise, the trace from step g) shall be used for step j).
- j) Place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “-xx dB down amplitude” determined in step h). If a marker is below this “-xx dB down amplitude” value, then it shall be as close as possible to this value. The occupied bandwidth is the frequency difference between the two markers. Alternatively, set a marker at the lowest frequency of the envelope of the spectral display, such that the marker is at or slightly below the “-xx dB down amplitude” determined in step h). Reset the marker-delta function and move the marker to the other side of the emission until the delta marker amplitude is at the same level as the reference marker amplitude. The marker-delta frequency reading at this point is the specified emission bandwidth.
- k) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Requirement: FCC Part 15.247 Clause (a,1,i)

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.